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EXPERT SYSTEM FOR LAND RESOURCE MANAGEMENT USING DATA MINING

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Abstract: **This paper presents the soil site suitability for crop with the Expert System for Land Resource Management Using Data Mining (ESLRM) in Andaman and Nicobar Islands. The aim of this study is to develop an expert system which measuring the soils various attribute and providing the recommendation for crop, based on rule based logic that the soil is highly suitable, moderately suitable or unsuitable for particular crop cultivation, and also giving the limitation details like poor drainage, no limitation, severe erosion and drought, very low pH, high salinity, mg deficiency drought and mg deficiency, moderate erosion or severe erosion, and giving out up to date scientific information in a readily accessible and easily understandable way for the farmer or any end user. The developed expert system integrates an user interface, knowledgebase, rule based and inference engine where in the help of user interface user can enter the soil parameters for selecting the suitable site for cultivating the crop, if the user not entering all the parameter it will show the error and it will ask you to enter the parameter in the help of inference engine. Knowledgebase contain all the details of soil and crop to provide the accurate recommendation to user. Rule based will clarify the process of logic and inference engine applies the rules then supervising and calculating a variety of process in the knowledgebase. Finally it will helpful to recommend the proper soil site suitability for which crop should be taken on the particular soil for cultivation to the farmers of Andaman and Nicobar Islands to making good yield, using data mining techniques for analysis of soil and crop dataset. Here an expert system using data mining classification algorithm for categorizing the soil and crop for proper recommendation of soil site suitability for crop.**

Keywords: Expert system, knowledgebase, inference engine, rule-based, data mining, soil site suitability.

I.INTRODUUCTION

Expert System is a branch of Artificial Intelligence and presently getting more importance especially in Agriculture. the basic idea of an Expert system is that to provide accurate solution for the particular problem and it contains complete information in the knowledgebase which is transferred from human (Expert in the particular domain) to computer in the help of knowledge engineer. Then user can give request to the system for extracting advice or recommendation as needed, then in the help of inference engine extracting solution from the knowledgebase and respond to the end user, like doctor giving medicine to the patient after checkup. An expert system has increase importance for data collection, organization, transmission, and recommendation [17]. An expert systems are broadly using to solve the problematical and critical troubles in several fields like medicine and agriculture being one of them. Expert system can be defined as a tool for information generation from knowledgebase. In Agriculture domain soil information is very essential for planning the proper soil use for cultivating the correct crop [2]. The physical attribute of soil play an important role to find out its suitability for crop production [3]. The production planning expert systems deal with planning of cropping actions which will help to make gainful cropping plans [4]. PLANT Expert System predicts the damage to corn caused by the invasion of black cutworms [5]. An agricultural Decision Support System usually enforces a structure on a decision. This may be unlike from that perceived by the decision-maker [6]. An expert Systems are used in a variety of application areas. One such area is the evaluation of natural resources management. A prototype for an expert system for cucumber seedlings productions was developed and it has six functions: seeds cultivation, media preparation, control environmental growth factors, diagnosis, treatment, and protection [18]. The purpose of this study is to develop an expert system for land resource management using data mining approach in Andaman and Nicobar Islands, to provide the soil information for selecting suitable place for correct crop cultivation to the farmers and also all the user . The soil dataset were collected from CIARI, Port Blair, Andaman and Nicobar Islands. Specific objective includes: (1) selecting the crop from user interface, (2) enter the parameters of the soil for the selected location, (3) after entering the soil parameters, in the help of inference engine it will extract the suitable solution from the knowledgebase and give the suitability class recommendation whether the given soil

parameters is highly suitable, moderately suitable or unsuitable for the selected crop.

II. RESEARCH METHODOLOGY

The knowledge of the kind of soils and their extent is very essential for sound land use planning.

Properties such as soil organic carbon content, iron content, water content, pH range and texture have been shown to have good relationship with soil colour, for good fertile and suitable for plant growth [13]. Soil resource inventory provides this kind of information, achieved through field survey and cartography. During the systematic soil survey of the revenue area of Andaman and Nicobar islands, it was observed that a great variety of soils (8 soil series) occur in these islands [1]. Land use suitability study is the process of finding the suitability of a given land area for a certain type of use agriculture purpose, and the level of suitability [9]. The information of the soils are classified into three orders, seven sub-orders and established eight series. The terrain is undulating ranging from steep slopes to coastal plains. Physiographical of these soil series are grouped into soils on flat lands and soils on the hill slopes. Shown in Figure 1: referred from (A.N.Ganeshamurthy, *et al*, 2002.).

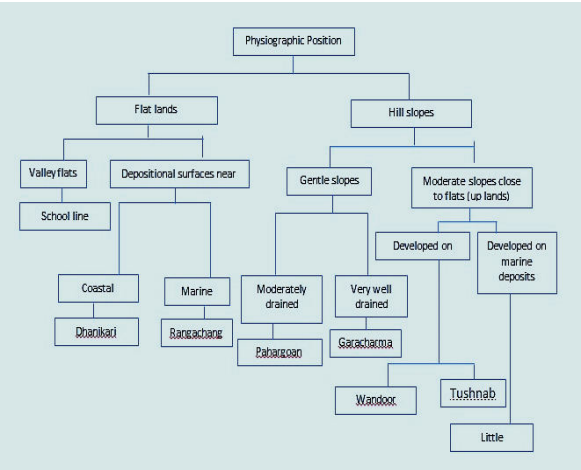

Figure 1: Physiographic positions of soil
(Source: AN.Ganeshamurthy, *et al*, 2002. Land Resources of Andaman and Nicobar Islands, Central Agricultural Research Institute, ICAR).

2.1 KNOWLEDGE ACQUISITION

The dataset is a part of surveys which are carried out frequently in Port Blair, primary data for the soil survey were collected by field sampling. These samples are then sent for chemical and physical analysis at the soil testing laboratories and soil were tested using soil test kit, and dataset was collected from Division of Natural Resource Management, CIARI (Central Island Agricultural Research Management), Port Blair, and there are eight (8) soil series were found in the Islands [1]. Automatic knowledge acquisition is a general research issue in expert systems development [19]. In Agriculture, research can be directed toward using the knowledge models developed for specific tasks in building tools to acquire the domain knowledge interactively with the domain experts.

2.1.1 TOPOGRAPHY AND SLOPE OF ANDAMAN AND NICOBAR ISLANDS

The topography of the islands is mostly hilly, undulating with intervening valleys. Slope characteristics help in understanding the relation among the lithology, landforms and land use. Slope is considered important in soil genesis and land use [1]. The Slope degree is the main reason to find out the soil erosion control [11]. The slope-class and their symbols generally used are given in Table 1: (Source: Field Manual, 1987, NBSS & LUP, Nagpur). There are seven categories of slopes in Andaman and Nicobar islands. In view of that, topography analysis is the most useful in location wise where the topographic shape is strongly related to the processes driving soil formation [15].

Table 1: Slope class and symbol

Class	Symbol	Slope (%)
Level to nearly level	A	0-1
Very gently sloping	B	1-3
Gently sloping	C	3-8
Moderately sloping	D	8-15
Moderately steeply sloping	E	15-30
steeply sloping	F	30-50
Very steeply sloping	G	>50

2.1.2 SOIL DEPTH OF ANDAMAN AND NICOBAR ISLANDS

The soil depth is vital importance for plant growth. The soils of Andaman and Nicobar Islands have been grouped into four depth classes generalized as 0-25 cm, 26-50 cm, 51-100 cm, and >101 cm for broad recommendations. Soil depth is straightly related to topography, parent material, living organisms and climate [7]. It is measured that the effective soil depth as the main property, since this is directly correlated to water availability by the root [14]. The soil depth used at different category levels is given in Table 2 [1].

Table 2: Classes of soil depth as used in different levels of soil taxonomy

Soil depth (cm)	**Used for defining**	
	Series	**Family**
<10	Extremely shallow	Very shallow
10-25	Very shallow	Very shallow
26-50	Shallow	Shallow
51-75	Moderately shallow	shallow
76-100	Moderately deep	Medium
101-150	Deep	Deep
>151	Very deep	Deep

2.1.3 SOIL PH RANGE IN ANDAMAN AND NICOBAR ISLANDS

The commonly encountered pH range soil is 5.5 to 8.5 however pH lower than 4.5 and higher than 9.5 are also observed in strongly acidic and alkaline soils, respectively. Based on the relative degree of acidity, the soils are divided into several acidity or alkalinity classes as given below Table [1]. The soil pH map of Andaman and Nicobar Island suggests that major soil types are moderately acidic with pH ranging from 5.5 to 6.5, covering the hill slope soils.

Table 3: Soil pH range

pH range	Reaction
<4.5	Strongly acidic
4.5-5.5	Moderately acidic
5.5-6.5	Slightly acidic
6.5-7.5	Neutral
7.5-8.5	Slightly alkaline
8.5-9.5	Moderately alkaline
>9.5	Strongly alkaline

2.1.4 VALUATION OF SOIL QUALITIES

The Soil sample instances were classified into the fertility class labels [1] as give below

Table 4: Fertility class Label

Land Quality					
Availability	VH	H	M	L	VL
Hazard/ Limitation	N	W	M	S	VS

(1) Very High (VH), High (H), Moderately (M), Low (L), Very Low (VL)
(2) Not Present (N), Weak (W), Moderate (M), Serious (S), Very Serious (VS)

[1] Using the above fertility class label it is evaluating the characteristic of Climate, Soil, Land Management and Profile description depth in (cm), and each of them is having its own attributes and that is checked by the above table class land quality with availability (1) and Hazard/Limitation (2). It is mentioned that the attribute of soil texture, soil moisture, soil consistency, soil EC, soil pH, organic matter content and slope is necessary for the agricultural land suitability analysis [10]. It is stated that the land evaluation studies focus on land output through the cropping system [12].

III. THE ARCHITECTURE OF ESLRM

The ESLRM providing to find out the soil site suitability for a selected crop in a particular location to the farmers and other users and it will be benefited to the Islands people to get the proper knowledge of soil and accordingly they can do better cultivation with good yield which will help to make good profit, here it is providing recommendation on the bases of crop wise as well as location wise. The architecture of ESLRM is included user interface, Inference engine, Knowledgebase and developer interface. The user interface which provides a means of communicating with ESLRM to fetch the crop recommendation for the soil for cultivation from an expert system, the knowledge base holding the complete facts of Islands soil, Inference engine applied rule based to the knowledge base and infer new knowledge and respond to the user. If domain expert need any modification in knowledge base then knowledge engineer representing the knowledge in the help of developer interface using the If-Then rule in the system. CROPLOT developed for the intension to find out the suitability of crops to given plots [16].The relationship between these components is shown below Figure 2.

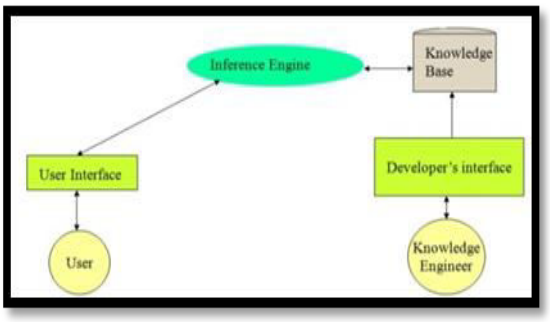

Figure 2: Components of ESLRM

3.1 SYSTEM OPERATION

ESLRM tool developed using ASP.NET as a front end and back end SQL Server. It is mentioned that the recent application that uses machine learning to agriculture data and this approach can be very useful when data sets are available in certain area. In this development the collected soil dataset has 11 attributes which is described in Table 5.

Table 5: Attributes Description

Parameter	Description
D (cm)	Soil Depth in (cm)
Sd texture	Sand texture %
St texture	Silt texture %
Cl texture	Clay texture %
pH	Potential hydrogen ion concentration value of soil
Org C	Organic Carbon %
EC (dsm^{-1})	Electrical Conductivity, decisiemen per meter
E.B	Exch. Bases value
P	Available Phosphorus
K	Available Potassium
Sl	Slope %

Three crops have been selected for site suitability which is black pepper and tree crops coconut and arecanut [1]. The above table's soil parameter each has its own attribute; all attribute is having values and it is in the knowledge base, on the basis of entering the values to the parameter it will give recommendation, whether the site suitability for the crop is highly suitable, moderately suitable or unsuitable. The recommendation is giving from the knowledge base using classification algorithm C4.5. This recommendation is giving only for 8 soil series are shown in Table 6 which describes the series wise distribution of soil in different areas in the islands [1].

Table 6: Soil Series

Order	Suborder	Great Group	Name of Series	Soil series (Area in ha)
Entisol	Fluvents	Tropofluvents	School Line	School line (7000)
Entisol	Orthents	Troporthents	Garacharma	Garacharma (5680)
Entisol	Aquents	Fluentic Sulfaquents	Dhanikhari	Dhanikhari (5860)
Entisol	Psamments	Fluventic quartzi-psamments	Rangachang	Rangachang (4811)
Inceptisols	Aquepts	Umbaric fluventic haplaquepts	Tushnabad	Tushnabad (2396)
Inceptisols	Ochrepts	Typic dystrochrepts	Pahargoan	Pahargoan
Inceptisols	Ochrepts	Fluventic dystrochrepts	Wandoor	Wandoor (19523)
Alfisols	Ustalfs	Haplustalfs	Little Andaman	Little Andaman (4895)

3.1.1 INPUT VARIABLES

The attribute of the soils input variable in the ESLRM which are pdn is pedon, it is not a soil parameter, it is a soil series, d-depth/(cm), sd-sand, st-silt, cl-clay, pH- Potential hydrogen ion concentration value of soil, org-organic carbon, exch bases- , ec-Electrical Conductivity (dpm) , p-phosphorus, k-pottasium, sl-slope. The rule base working in the following manner

If (condition) then recommendation ElseIf (condition) then recommendation ElseIf (condition) then recommendation Else (condition) ……. Else () End If

IV. RESULTS AND DISCUSSION

The results were taken for three crops using the train dataset which shown in Figure 3, 4 and 5. The inference engine designed in the ESLRM is forward chaining. The inference engine process is taking the parameter value from the user, according to the selected parameters the inference engine of the ESLRM checks the condition by checking the rules stored in the knowledgebase, and extracting the processed information from the knowledgebase and giving the suitable recommendation for the crop.

Rule 1: If (pdn=val and d=val and sd<=val and st<=100 and cl<=val and pH>=val and org>= val and ec>=val and exch.bases >=val and p>=val and k>=val and sl<=val) then unsuitable for arecnut.

Rule 2: If (pdn=val and d=val and sd<=val and st<=100 and cl<=val and pH>=val and org>= val and ec>=val and exch.bases >=val and p>=val and k>=val and sl<=val)then Highly suitable for Arecnut.

Rule 3: If (pdn=val and d=val and sd<=val and st<=100 and cl<=val and pH>=val and org>=val and ec>=val and exch.bases >=val and p>=val and k>=val and sl<=val)then Moderately suitable for Arecnut.

The above rule mentioned "val" is value of the soil parameter and the value is differ in every rule according to the value it is giving the recommendation. The above rule is given for arecanut crop cultivation for the soil series i.e Order: Entisol, Suborder:Fluvents, Orthents, Aquents, name of series is: School Line, Garacharma, Dhanikhari. It is developed for 8 soil series to recommending land suitability for three crops.

Figure 3: Crop selection by the ESLRM

Description: In this screen shot, the user can select the particular crop which he need the recommendation for site suitability from the ESLRM by selecting the radio button.

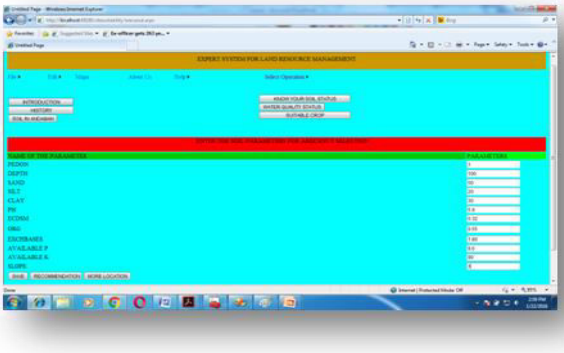

Figure 4: Data entry form by the User

Description: In this screen shot, the soil parameter value given as an input by the user or submitting the request to the Expert System for Land Resource Management for recommendation whether the crop is suitable, moderately suitable or unsuitable for the site.

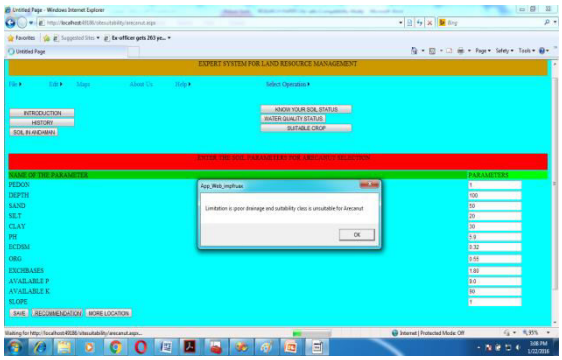

Figure 5: Site suitability recommendation for Arecanut (Crop) by ESLRM

Description: In this screen shot, after taking the input from the user, the Inference engine mining the data from the knowledgebase using rule based and C4.5 Classification Algorithm, and producing the following processed information or recommendation to the user .

V. CONCLUSION

This study has briefly given details of ESLRM expert system which developed as a prototype and it gives soil site suitability recommendation for the selected crops namely arecanut, coconut and black Pepper for 8 soil series. An interface between user and ESLRM has been developed and presented to select the crop site suitability. This system has used to train data in the decision tree classification algorithms to classify the soil series and give appropriate recommendation to the user. It is concluded that the ESLRM system is an effective tool, and further it will be enhanced with one more additional module which will give fertilizer recommendation for the soil.

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